

## TITLE OF THE INVENTION

AUDIO SIGNAL RECORDING APPARATUS

### CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based upon and claims the  
5 benefit of priority from prior Japanese Patent  
Application No. 2003-188490, filed June 30, 2003, the  
entire contents of which are incorporated herein by  
reference.

### BACKGROUND OF THE INVENTION

#### 10 1. Field of the Invention

This invention relates to an audio signal input  
circuit in a sound recording/reproducing apparatus.

#### 2. Description of the Related Art

An ordinary stereo external microphone is  
15 connected to a recording apparatus via a plug having  
three electrodes. The electrodes are respectively  
defined, from a plug end, as a left channel (L), a  
right channel (R) and a ground (GND).

An audio signal from the microphone is input to  
20 microphone amplifiers of the right and left channels  
via the plug, and amplified and then sent to a next  
stage circuit. In a plug-in power system, power for  
the microphone is supplied from a microphone power  
supply circuit of the recording apparatus to the right  
25 and left channels of the external microphone respec-  
tively via a resistance and an audio signal line.

If a plug of a monaural external microphone is

connected to a jack for the stereo external microphone,  
no signal is input to the right channel amplifier.  
Sound is recorded only in the left channel, and no  
sound is recorded in the right channel. This therefore  
5 results in wasteful use of a recording medium which  
records the audio signals, and a sound is output only  
from the left when reproduced.

Jpn. Pat. Appln. KOKAI Publication No. 2000-333500  
(page 4, FIG. 5) discloses an apparatus which deter-  
10 mines whether an input audio signal is a stereo sound  
or monaural sound. In this document, a software stored  
in a ROM judges whether the input audio signal is  
stereo or monaural.

A conventional sound recording/reproducing  
15 apparatus is not capable of judging whether the  
microphone connected to a microphone input terminal  
(microphone jack) is a stereo microphone or monaural  
microphone. In the document mentioned above, computing  
processing is performed in an MPU to judge whether the  
20 input audio signal is stereo or monaural, but a  
specific method is not described, and it can not be  
readily implemented.

#### BRIEF SUMMARY OF THE INVENTION

A sound recording apparatus according to one  
25 embodiment of the present invention comprises: a  
microphone input terminal having right and left signal  
channel terminals and a ground terminal; a recording

section which records, in a recording medium, right and left audio signals input from the microphone input terminal; a microphone power supply section which supplies power to a microphone connected to the microphone input terminal via the right and left signal channel terminals and the ground terminal; a detection section which detects whether or not a voltage of one of the right and left signal channel terminals is substantially the same as a voltage of the ground terminal, and provides a detection result; and a control section which controls a recording operation of the recording section in accordance with the detection result.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention, and together with the general description given above and the detailed description of the embodiments given below, serve to explain the principles of the invention.

FIG. 1 is a block configuration diagram of a sound recording/reproducing apparatus according to the present invention;

FIG. 2 is a diagram showing a schematic configuration of an external microphone input section 20;

FIG. 3 is a diagram showing a schematic configuration of a stereo microphone;

FIG. 4 is a diagram showing a configuration example of a DC voltage detection section 15;

FIG. 5 shows the external microphone input section 20 when a monaural microphone is connected thereto; and

5        FIG. 6 is a diagram showing a configuration in a second embodiment of the external microphone input section.

#### DETAILED DESCRIPTION OF THE INVENTION

Embodiments of the present invention will  
10        hereinafter be described in detail referring to the drawings.

FIG. 1 is a block configuration diagram of a sound recording/reproducing apparatus to which the present invention is applied. An internal microphone 1  
15        converts an input sound into an audio signal, and a microphone amplifier 2 amplifies the audio signal. An external microphone input section 20 inputs and amplifies the audio signal from a stereo or monaural microphone connected to the present apparatus, and  
20        provides a right audio signal  $R_{in}$  and a left audio signal  $L_{in}$ . The external microphone input section 20 also detects whether the external microphone is a stereo microphone or monaural microphone, and provides a signal DTS indicating a detection result to a system  
25        control section 5. Further, the external microphone input section 20 provides a signal EXM indicating whether or not a microphone plug is plugged into the

external microphone input section 20.

5 A signal switch circuit (SW) 3 selects one of the audio signals Lin and Rin from the external microphone, and an audio signal Min from the internal microphone on the basis of the signal EXM or a signal INS (described later) from the system control section 5, and provides it to an A/D converter 4. When the external microphone is not connected, the signal switch circuit 3 selects the audio signal Min from the microphone amplifier 2.

10 When the microphone plug is plugged into the external microphone input section 20, the external microphone input section 20 outputs, for example, an H (high) level as the signal EXM. In response to the H level of the signal EXM, the signal switch circuit 3 selects the

15 signal from the external microphone input section 20.

The A/D converter 4 converts the analog audio signal selected by the signal switch circuit 3 into a digital signal. Under the control of the system control section 5, a digital signal processing section

20 (DSP) 12 compresses (encodes) the digital signal provided from the A/D converter 4. The system control section 5 records compressed data as a file in a recording medium (semiconductor memory card) 6.

An operation button section 11 is a user interface

25 for inputting user instructions, and includes a record button (REC), a play button (PLAY), a stop button (STOP), a fast-forward button (FF) and a rewind button

(REW). The system control section (CPU) 5 controls each circuit block in the present apparatus in accordance with the button depressed by a user.

5 A display section 7 comprises, for example, an LCD (liquid crystal display), and includes a file number display portion 7a, a reproduction mode display portion 7b, recording mode display portion 7c, and a recording or reproduction elapsed time display portion 7d.

10 In sound reproduction, the system control section 5 reads the audio data recorded as a file in the recording medium 6, and decodes (extends) it by the DSP 12. The decoded audio data is converted into an analog audio signal by a D/A converter 8, amplified by an amplifier 9, and output as a sound by a speaker 10.

15 Next, a configuration of the external microphone input section 20 according to the present invention will be described.

FIG. 2 is a diagram showing a schematic configuration of the external microphone input section 20. In this diagram, an external stereo microphone plug 21S is connected to the external microphone input section 20. The external microphone input section 20 comprises a microphone input terminal having right and left signal channel terminals 16R, 16L and a ground terminal 16G.

25 A plug-in power system is adopted in the external microphone input section 20. That is, power is

supplied to both the right and left channels of the stereo microphone from a microphone power supply 12 via power supply resistances r1 and r2. The audio signals from the microphone are input to microphone amplifiers 13, 14 of both the right and left channels, and amplified and then sent to a next stage. A plug detection section 18 detects whether or not the microphone plug is plugged into the external microphone input section 20, and provides the detection signal EXM.

FIG. 3 is a diagram showing a schematic configuration of a stereo microphone. A stereo microphone 22 is comprised of a right microphone 22R and a left microphone 22L, and each microphone is, for example, an electret capacitor microphone and has an internal resistance ZR. Each microphone is supplied with power via a plug 21S and signal lines 21R, 21L in a cable, and converts an input sound into an audio signal, and then outputs it to the signal lines 21R, 21L.

Next, a DC voltage detection section 15 provided in the external microphone input section 20 will be described.

FIG. 4 shows a configuration example of the DC voltage detection section 15. The DC voltage detection section 15 detects that a voltage of a right channel power supply line is substantially a DC voltage of 0 V, thereby determining whether the connected external

microphone is stereo or monaural. The right channel  
signal input terminal 16R is connected to an inverted  
terminal of a comparator 17, and also connected to  
one end of the resistance r1. The other end of the  
5 resistance r1 is connected to the microphone power  
supply 12, and supplied with a microphone power supply  
voltage Vmic. A noninverted terminal of the comparator  
17 is supplied with a threshold voltage Vref.

A detection voltage Vdet in the DC voltage  
10 detection section 15 will be a voltage in which the  
microphone power supply voltage Vmic is resistance-  
divided by the power supply resistance r1 and the  
internal resistance ZR of the right channel microphone.  
The Vdet is indicated by the following Equation.

15 
$$V_{det} = (Z_R / (r_1 + Z_R)) * V_{mic} [V] \quad \dots(1)$$

FIG. 5 shows the external microphone input section  
20 when a monaural microphone is connected thereto.  
Due to a plug shape of a plug 21M, the right channel  
power supply resistance r1 is connected to the GND via  
20 the plug, so that the Vdet will be a GND potential.

$$V_{det} = 0 [V] \quad \dots(2)$$

The threshold voltage Vref for determination is  
decided from Equations (1) and (2), and the detection  
voltage Vdet is compared with the threshold voltage  
25 Vref. If the Vdet is smaller than the threshold  
voltage Vref, an H level signal is output as the  
detected signal DTS from the comparator 17, or if the



Vdet is above the threshold voltage Vref, an L (low) level signal is output as the detected signal DTS. The system control section 5 determines that a monaural microphone is connected when the detected signal DTS is on the H level, and that a stereo microphone is connected when the detected signal DTS is on the L level.

When the monaural microphone is connected to the external microphone input section 20, the system control section 5 controls the DSP 12 so that, for example, the audio signal of the left channel is recorded by use of both right and left recording channels. This makes it possible to output a sound to both the right and left channels in reproduction. When the monaural microphone is connected to the external microphone input section 20, the system control section 5 may also control the DSP 12 so that only the audio signal of the left channel is recorded in the recording medium 6 by use of the left recording channel. This makes it possible to prolong recording time of the audio signal that can be recorded in the recording medium 6, as compared with conventional cases in which a right channel signal with no sound is simultaneously recorded.

FIG. 6 is a diagram showing a configuration in a second embodiment of the external microphone input section 20.

In the present embodiment, the voltage Vdet of the right signal terminal 16R is measured by the A/D converter 4, and the system control section 5 judges whether the external microphone is stereo or monaural.

5 Generally, a DC voltage can not be input to the microphone amplifiers 13, 14 because a capacitor is inserted in series into an signal input line (not shown). Therefore, the voltage Vdet of the right signal terminal is input to the A/D converter 4 without  
10 passing through the capacitor in the present embodiment.

The voltage Vdet of the right signal terminal is first supplied to the signal switch circuit (SW) 3 (not shown). For example, when the power is turned on, or  
15 every time the microphone plug is plugged into the external microphone input section 20, the system control section 5 switches the signal switch circuit (SW) 3 to a Vdet side by the signal INS, so as to read the voltage Vdet via the A/D converter 4 and compare it  
20 with a predetermined threshold value. If a value of the voltage Vdet is smaller than the predetermined threshold value, the system control section 5 judges that a monaural plug is connected to the external microphone input section 20, and changes a recording  
25 operation of the digital signal processing section 12 for monaural use as described above.

Additional advantages and modifications will

readily occur to those skilled in the art. Therefore,  
the invention in its broader aspects is not limited to  
the specific details and representative embodiments  
shown and described herein. Accordingly, various  
5 modifications may be made without departing from the  
spirit or scope of the general invention concept as  
defined by the appended claims and their equivalents.